

VARIABLE	ANNOTATION
A	Set of arcs
R	Set of user's origins
S	Set of user's destinations
u	Maximal number of path provided to each user
l	Minimal number of path provided to each user
$\Pi_u^{r,s}$	The u -shortest paths connecting OD pair $r \in R$ and $s \in S$ under UE flow pattern
x_a	The arc flow of arc $a \in A$
t_a	The arc travel time of arc $a \in A$
$n^{r,s}$	Number of paths among provided to users between OD pair $r \in R$ and $s \in S$
$h_\pi^{r,s}$	The flow of path $\pi \in \Pi_u^{r,s}$ between OD pair $r \in R$ and $s \in S$
$\delta_{a,\pi}^{r,s}$	$\delta_{a,\pi}^{r,s} = 1$ if arc $a \in A$ is included in path $\pi \in \Pi_u^{r,s}$ connecting OD pair $r \in R$ and $s \in S$; $\delta_{a,\pi}^{r,s} = 0$ otherwise
$\tau_\pi^{r,s}$	$\tau_\pi^{r,s} = 0$ if user is aware of path $\pi \in \Pi_u^{r,s}$ connecting OD pair $r \in R$ and $s \in S$; $\tau_\pi^{r,s} = 1$ otherwise
$q^{r,s}$	The fixed and deterministic OD demand between OD pair $r \in R$ and $s \in S$

$$\min F(\mathbf{x}, \tau) = \sum_{a \in A} x_a t_a(x_a) + \sum_{r \in R} \sum_{s \in S} \sum_{\pi \in \Pi_u^{r,s}} (1 - \tau_\pi^{r,s})$$

$$s. t. \begin{cases} \sum_{\pi \in \Pi_u^{r,s}} (1 - \tau_\pi^{r,s}) \geq l & \forall r \in R, \forall s \in S \\ \sum_{\pi \in \Pi_u^{r,s}} (1 - \tau_\pi^{r,s}) \leq u & \forall r \in R, \forall s \in S \end{cases}$$

where $\mathbf{x} = \mathbf{x}(\tau)$ is implicitly determined by:

$$\min f(\mathbf{x}, \tau) = \sum_{a \in A} \int \sum_{r \in R} \sum_{s \in S} \sum_{\pi \in \Pi_u^{r,s}} \delta_{a,\pi}^{r,s} h_\pi^{r,s} t_a(x) dx$$

$$s. t. \begin{cases} \sum_{\pi \in \Pi_u^{r,s}} h_\pi^{r,s} = q^{r,s}, & \forall r \in R, \forall s \in S \\ h_\pi^{r,s} \geq 0, & \forall r \in R, \forall s \in S, \forall \pi \in \Pi_u^{r,s} \\ \tau_\pi^{r,s} h_\pi^{r,s} = 0, & \forall r \in R, \forall s \in S, \forall \pi \in \Pi_u^{r,s} \end{cases}$$

